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The Communications Practices of U.S. Aerospace Engineering Faculty and Students: Results of the Phase 3 Survey

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## THE COMMUNICATION PRACTICES OF U.S. AEROSPACE ENGINEERING FACULTY AND STUDENTS: RESULTS OF THE PHASE 3 SURVEY

Thomas E. Pinelli, Rebecca O. Barclay, and John M. Kennedy

### **ABSTRACT**

The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. Little is also known about the intermediary-based system that is used to transfer the results of federally funded R&D to the U.S. aerospace industry. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the NASA/DoD Aerospace Knowledge Diffusion Research Project. In this report, we summarize the literature on technical reports, present a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-à-vis U.S. aerospace engineering faculty and students.

### INTRODUCTION

NASA and the DoD maintain scientific and technical information (STI) systems for acquiring, processing, announcing, publishing, and transferring the results of government-performed and government-sponsored research. Within both the NASA and DoD STI systems, the U.S. government technical report is considered a primary mechanism for transferring the results of this research to the U.S. aerospace community. However, McClure (1988) concludes that we actually know little about the role, importance, and impact of the technical report in the transfer of federally funded R&D because little empirical information about this product is available. The NASA and DoD STI systems are intermediary-based systems that rely on librarians and technical information specialists to complete the knowledge transfer process. To date, empirical findings on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive (Beyer and Trice, 1982).

We are examining the system(s) used to diffuse the results of federally funded aerospace R&D as part of the NASA/DoD Aerospace Knowledge Diffusion Research Project. This project investigates, among other things, the information-seeking behavior of U.S. aerospace engineers and scientists and the role of academia- and industry-affiliated information intermediaries in the aerospace knowledge diffusion process (Pinelli, Kennedy, and Barclay, 1991; Pinelli, Kennedy, Barclay, and White, 1991). The results of this investigation could (1) advance the development of practical theory, (2) contribute to the design and development of aerospace information systems, and (3) have practical implications for transferring the results of federally funded aerospace R&D to the U.S. aerospace community. The project fact sheet is Appendix A.

In this report, we summarize the literature on technical reports, provide a model that depicts the transfer of federally funded aerospace R&D through the U.S. government technical report, and present the results of a survey of U.S. aerospace engineering faculty and students. We summarize the findings of the survey and close with some thoughts regarding the information-seeking behavior of aerospace engineering faculty and students.

#### THE U.S. GOVERNMENT TECHNICAL REPORT

Although they have the potential for increasing technological innovation, productivity, and economic competitiveness, U.S. government technical reports may not be utilized because of limitations in the existing transfer mechanism. According to Ballard, et al. (1986), the current system "virtually guarantees that much of the Federal investment in creating STI will not be paid back in terms of tangible products and innovations." They further state that "a more active and coordinated role in STI transfer is needed at the Federal level if technical reports are to be better utilized."

### **Characteristics of Technical Reports**

The definition of the technical report varies because the report serves different roles in communication within and between organizations. The technical report has been defined etymologically, according to report content and method (U.S. Department of Defense, 1964); behaviorally, according to the influence on the reader (Ronco, et al. 1964); and rhetorically, according to the function of the report within a system for communicating STI (Mathes and Stevenson, 1976). The boundaries of technical report literature are difficult to establish because of wide variations in the content, purpose, and audience being addressed. The nature of the report -- whether it is informative, analytical, or assertive -- contributes to the difficulty.

Fry (1953) points out that technical reports are heterogenous, appearing in many shapes, sizes, layouts, and bindings. According to Smith (1981), "Their formats vary; they might be brief (two pages) or lengthy (500 pages). They appear as microfiche, computer printouts or vugraphs, and often they are loose leaf (with periodic changes that need to be inserted) or have a paper cover, and often contain foldouts. They slump on the shelf, their staples or prong fasteners snag other documents on the shelf, and they are not neat."

Technical reports may exhibit some or all of the following characteristics (Gibb and Phillips, 1979; Subramanyam, 1981):

- Publication is not through the publishing trade.
- Readership/audience is usually limited.
- Distribution may be limited or restricted.

- Content may include statistical data, catalogs, directions, design criteria, conference papers and proceedings, literature reviews, or bibliographies.
- Publication may involve a variety of printing and binding methods.

The SATCOM report (National Academy of Sciences - National Academy of Engineering, 1969) lists the following characteristics of the technical report:

- It is written for an individual or organization that has the right to require such reports.
- It is basically a stewardship report to some agency that has funded the research being reported.
- It permits prompt dissemination of data results on a typically flexible distribution basis.
- It can convey the total research story, including exhaustive exposition, detailed tables, ample illustrations, and full discussion of unsuccessful approaches.

### History and Growth of the U.S. Government Technical Report

The development of the [U.S. government] technical report as a major means of communicating the results of R&D, according to Godfrey and Redman (1973), dates back to 1941 and the establishment of the U.S. Office of Scientific Research and Development (OSRD). Further, the growth of the U.S. government technical report coincides with the expanding role of the Federal government in science and technology during the post World War II era. However, U.S. government technical reports have existed for several decades. The Bureau of Mines Reports of Investigation (Redman, 1965/66), the Professional Papers of the United States Geological Survey, and the Technological Papers of the National Bureau of Standards (Auger, 1975) are early examples of U.S. government technical reports. Perhaps the first U.S. government publications officially created to document the results of federally funded (U.S.) R&D were the technical reports first published by the National Advisory Committee for Aeronautics (NACA) in 1917.

Auger (1975) states that "the history of technical report literature in the U.S. coincides almost entirely with the development of aeronautics, the aviation industry, and the creation of the NACA, which issued its first report in 1917." In her study, *Information Transfer in Engineering*, Shuchman (1981) reports that 75 percent of the engineers she surveyed used technical reports; that technical reports were important to engineers doing applied work; and that aerospace engineers, more than any other group of engineers, referred to technical reports. However, in many of these studies, including Shuchman's, it is often unclear whether U.S. government technical reports, non-U.S. government technical reports, or both are included.

The U.S. government technical report is a primary means by which the results of federally funded R&D are made available to the scientific community and are added to the literature of

science and technology (President's Special Assistant for Science and Technology, 1962). McClure (1988) points out that "although the [U.S.] government technical report has been variously reviewed, compared, and contrasted, there is no real knowledge base regarding the role, production, use, and importance [of this information product] in terms of accomplishing this task." Our analysis of the literature supports the following conclusions reached by McClure:

- The body of available knowledge is simply inadequate and noncomparable to determine the role that the U.S. government technical report plays in transferring the results of federally funded R&D.
- Further, most of the available knowledge is largely anecdotal, limited in scope and dated, and unfocused in the sense that it lacks a conceptual framework.
- The available knowledge does not lend itself to developing "normalized" answers to questions regarding U.S. government technical reports.

## THE TRANSFER OF FEDERALLY FUNDED AEROSPACE R&D AND THE U.S. GOVERNMENT TECHNICAL REPORT

Three paradigms -- appropriability, dissemination, and diffusion -- have dominated the transfer of federally funded (U.S.) R&D (Ballard, et al., 1989; Williams and Gibson, 1990). Whereas variations of them have been tried within different agencies, overall Federal (U.S.) STI transfer activities continue to be driven by a "supply-side," dissemination model.

### The Appropriability Model

The appropriability model emphasizes the production of knowledge by the Federal government that would not otherwise be produced by the private sector and competitive market pressures to promote the use of that knowledge. This model emphasizes the production of basic research as the driving force behind technological development and economic growth and assumes that the Federal provision of R&D will be rapidly assimilated by the private sector. Deliberate transfer mechanisms and intervention by information intermediaries are viewed as unnecessary. Appropriability stresses the supply (production) of knowledge in sufficient quantity to attract potential users. Good technologies, according to this model, sell themselves and offer clear policy recommendations regarding Federal priorities for improving technological development and economic growth. This model incorrectly assumes that the results of federally funded R&D will be acquired and used by the private sector, ignores the fact that most basic research is irrelevant to technological innovation, and dismisses the process of technological innovation within the firm.

#### The Dissemination Model

The dissemination model emphasizes the need to transfer information to potential users and embraces the belief that the production of quality knowledge is not sufficient to ensure its fullest

use. Linkage mechanisms, such as information intermediaries, are needed to identify useful knowledge and to transfer it to potential users. This model assumes that if these mechanisms are available to link potential users with knowledge producers, then better opportunities exist for users to determine what knowledge is available, acquire it, and apply it to their needs. The strength of this model rests on the recognition that STI transfer and use are critical elements of the process of technological innovation. Its weakness lies in the fact that it is passive, for it does not take users into consideration except when they enter the system and request assistance. The dissemination model employs one-way, source-to-user transfer procedures that are seldom responsive in the user context. User requirements are seldom known or considered in the design of information products and services.

### The Knowledge Diffusion Model

The knowledge diffusion model is grounded in theory and practice associated with the diffusion of innovation and planned change research and the clinical models of social research Knowledge diffusion emphasizes "active" intervention as opposed to and mental health. dissemination and access; stresses intervention and reliance on interpersonal communications as a means of identifying and removing interpersonal barriers between users and producers; and assumes that knowledge production, transfer, and use are equally important components of the R&D process. This approach also emphasizes the link between producers, transfer agents, and users and seeks to develop user-oriented mechanisms (e.g., products and services) specifically tailored to the needs and circumstances of the user. It makes the assumption that the results of federally funded R&D will be under utilized unless they are relevant to users and ongoing relationships are developed among users and producers. The problem with the knowledge diffusion model is that (1) it requires a large Federal role and presence and (2) it runs contrary to the dominant assumptions of established Federal R&D policy. Although U.S. technology policy relies on a "dissemination-oriented" approach to STI transfer, other industrialized nations, such as Germany and Japan, are adopting "diffusion-oriented" policies which increase the power to absorb and employ new technologies productively (Branscomb, 1991; Branscomb, 1992).

### The Transfer of (U.S.) Federally-Funded Aerospace R&D

A model depicting the transfer of federally funded aerospace R&D through the U.S. government technical report appears in figure 1. The model is composed of two parts -- the informal that relies on collegial contacts and the formal that relies on surrogates, information producers, and information intermediaries to complete the "producer to user" transfer process.

When U.S. government (i.e., NASA) technical reports are published, the initial or primary distribution is made to libraries and technical information centers. Copies are sent to surrogates for secondary and subsequent distribution. A limited number of copies are set aside to be used by the author for the "scientist-to-scientist" exchange of information at the collegial level.

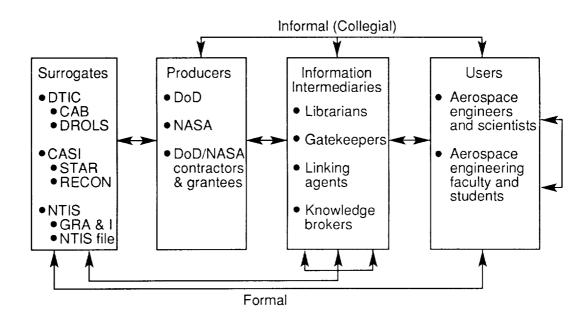


Figure 1. The U.S. Government Technical Report in a Model Depicting the Dissemination of Federally Funded Aerospace R&D.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Center for Aero Space Information (CASI), and the National Technical Information Service (NTIS). These surrogates have created a variety of technical report announcement journals such as CAB (Current Awareness Bibliographies), STAR (Scientific and Technical Aerospace Reports), and GRA&I (Government Reports Announcement and Index) and computerized retrieval systems such as DROLS (Defense RDT&E Online System), RECON (REsearch CONnection), and NTIS On-line that permit online access to technical report data bases. Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Those representing the producers serve as what McGowan and Loveless (1981) describe as "knowledge brokers" or "linking agents." Information intermediaries connected with users act, according to Allen (1977), as "technological entrepreneurs" or "gatekeepers." The more "active" the intermediary, the more effective the transfer process becomes (Goldhor and Lund, 1983). Active intermediaries move information from the producer to the user, often utilizing interpersonal (i.e., face-to-face) communication in the process. Passive information intermediaries, on the other hand, "simply array information for the taking, relying on the initiative of the user to request or search out the information that may be needed" (Eveland, 1987).

The overall problem with the total Federal STI system is that "the present system for transferring the results of federally funded STI is passive, fragmented, and unfocused;" effective knowledge transfer is hindered by the fact that the Federal government "has no coherent or systematically designed approach to transferring the results of federally funded R&D to the user" (Ballard, et al., 1986). In their study of issues and options in Federal STI, Bikson and her colleagues (1984) found that many of the interviewees believed "dissemination activities were

afterthoughts, undertaken without serious commitment by Federal agencies whose primary concerns were with [knowledge] production and not with knowledge transfer;" therefore, "much of what has been learned about [STI] and knowledge transfer has not been incorporated into federally supported information transfer activities."

Problematic to the **informal** part of the system is that knowledge users can learn from collegial contacts only what those contacts happen to know. Ample evidence supports the claim that no one researcher can know about or keep up with all the research in his/her area(s) of interest. Like other members of the scientific community, aerospace engineers and scientists are faced with the problem of too much information to know about, to keep up with, and to screen. Further, information is becoming more interdisciplinary in nature and more international in scope.

Two problems exist with the **formal** part of the system. First, the **formal** part of the system employs one-way, source-to-user transmission. The problem with this kind of transmission is that such formal one-way, "supply side" transfer procedures do not seem to be responsive to the user context (Bikson, et al., 1984). Rather, these efforts appear to start with an information system into which the users' requirements are retrofit (Adam, 1975). The consensus of the findings from the empirical research is that interactive, two-way communications are required for effective information transfer (Bikson, et al., 1984).

Second, the **formal** part relies heavily on information intermediaries to complete the know-ledge transfer process. However, a strong methodological base for measuring or assessing the effectiveness of the information intermediary is lacking (Beyer and Trice, 1982). In addition, empirical data on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive. The impact of information intermediaries is likely to be strongly conditional and limited to a specific institutional context.

According to Roberts and Frohman (1978), most Federal approaches to knowledge utilization have been ineffective in stimulating the diffusion of technological innovation. They claim that the numerous Federal STI programs are "highest in frequency and expense yet lowest in impact" and that Federal "information dissemination activities have led to little documented knowledge utilization." Roberts and Frohman also note that "governmental programs start to encourage utilization of knowledge only after the R&D results have been generated" rather than during the idea development phase of the innovation process. David (1986), Mowery (1983), and Mowery and Rosenberg (1979) conclude that successful [Federal] technological innovation rests more with the transfer and utilization of knowledge than with its production.

#### THE INFORMATION-SEEKING BEHAVIOR OF ENGINEERS

The information-seeking behavior of engineers and scientists has been variously studied by information and social scientists, the earliest studies having been undertaken in the late 1960s (Pinelli, 1991). The results of these studies have not accumulated to form a significant body of knowledge that can be used to develop a general theory regarding the information-seeking

behavior of engineers and scientists. The difficulty in applying the results of these studies has been attributed to the lack of a unifying theory, a standardized methodology, and the common definitions (Rohde, 1986).

Despite the fact that numerous "information use" studies have been conducted, the information-seeking behavior of engineers and information use in engineering are neither broadly known nor well understood. There are a number of reasons (Berul, et al., 1965): (1) many of the studies were conducted for narrow or specific purposes in unique environments such as experimental laboratories; (2) many, if not most, of them focused on scientists exclusively or engineers working in a research environment; (3) few studies have concentrated on engineers, especially engineers working in manufacturing and production; (4) from an information use standpoint, some engineering disciplines have yet to be studied; (5) most of the studies have concentrated on the users' use of information in terms of a library and/or specific information packages such as professional journals rather than how users produce, transfer, and use information; and (6) many of the studies, as previously stated, were not methodologically sophisticated and few included testable hypotheses or valid procedures for testing the study's hypotheses.

Further, we know very little about the diffusion of knowledge in specific communities such as aerospace. In the past 25 years, few studies have been devoted to understanding the information environment in which aerospace engineers and scientists work, the information-seeking behavior of aerospace engineers and scientists, and the factors that influence the use of federally funded aerospace STI. Presumably, the results of such studies would have implications for current and future aerospace STI systems and for making decisions regarding the transfer and use of federally funded aerospace STI.

### RESULTS OF THE PHASE 3 SURVEY

The U.S. faculty sample was obtained primarily from 4 year institutions participating in the 1990 NASA/USRA (University Space Research Association) capstone design programs in aerospace departments. Also included were some institutions with aerospace programs accredited by the Accreditation Board for Engineering and Technology (ABET). Questionnaires were sent to 501 faculty members, 275 (55%) of whom responded to the survey.

The student sample included those students enrolled in a NASA/USRA-funded undergraduate capstone course in the spring of 1990. Telephone calls and telefaxes to course instructors enlisted the participation of 39 instructors who agreed to distribute questionnaires to their students. (Some instructors could not participate because they had taught their capstone course during the fall semester.) Data were collected during April and May 1990. Some 640 students from 29 institutions responded.

A group of special librarians worked with the project team to compile the list of survey questions. The questions were pretested before distribution. The faculty and student mail (self-

reported) questionnaires, which are Appendixes B and C, were organized around the following topical objectives: use and importance of selected information sources and products, the use of specific print sources and electronic data bases, the use of computer and information technology, and instruction in information materials and resources. Data are presented for each of the topical objectives.

### **Demographics**

The following engineering faculty participant profile was based on Phase 3 survey demographic data which appear in table 1: is male (97.1%), is tenured (64.4%), holds the rank of professor (48.0%), holds a doctorate (80.4%), belongs to the American Institute of Aeronautics and Astronautics (AIAA) (66.5%), has an average of 14.5 years of academic professional aerospace work experience, is a NASA contractor or grantee (56.3%), and is a U.S. citizen (83.2%).

The following engineering student participant profile was based on Phase 3 survey demographic data which appear in table 2: is male (83.6%), is majoring in aero/astronautical engineering (80.4%), is a senior (91.7%), was not a cooperative education student (83.4%), is a student member of a national professional society (78.6%), is not a NASA contractor or grantee, and is a U.S. citizen (95.5%).

### Use and Importance of Information Sources and Products

Faculty and students were asked to indicate their use of and the importance to them of selected information sources to them (table 3). A 1 to 5 point scale was used to measure use and importance with "1" designated frequently\important and "5" designated never/unimportant. The percentages report combined "1" and "2" responses on a 5 point scale. Both faculty (95%) and students (68%) make considerable use of the information that they keep close at hand, presumably information kept in their offices and residences. Faculty (95%) and students (74%) place considerable importance on their personal collections of information. Both groups make considerable use of interpersonal communications in meeting their engineering information needs. University and engineering libraries are used by both groups and are important to both groups. Librarians are consulted less and are far less important to faculty and students than are other information sources.

The same 1 to 5 point scale was used to measure the use and importance that faculty and students place on specific information products in meeting their engineering information needs (table 4). The information products they use most are generally the products both groups rate important. Formal information products, such as journal articles, conference-meeting papers, and textbooks, are used most often and are rated most important. NASA technical reports, as well as all other products, have a higher importance rating than use rate. Faculty and students make little use of foreign technical reports and technical translations and rate them unimportant.

Table 1. Demographic Findings -- U.S. Aerospace Faculty [N = 272]

Demographics	%	(n)
Rank Held		'
Professor	48.0	122
Associate	20.9	53
Assistant	21.3	54
Adjunct	2.8	7
Instructor	2.8	7
Other	4.3	11
Tenured		
Yes	64.4	172
No	30.0	80
Not Applicable	5.6	15
Highest Level Of Education		
No Degree Or Vocational Degree		
Bachelor's Degree	1.5	4
Master's Degree	9.2	25
Doctorate	80.4	219
Post Doctorate	8.4	23
Citizenship		
U.S.	83.2	227
Other	16.8	46
Gender		
Female	2.9	8
Male	97.1	264
Years Of Professional Aerospace Work Experience In	<u>Mean</u>	Median
Academia	14.5	12.0
Government	5.1	2.0
Industry	5.9	3.0
Total	18.7	20.0
Professional (Society) Membership		
AIAA	66.5	183
ASME	36.0	99
IEEE	12.7	35
SAE	6.5	18
Other	57.1	157
None	3.3	9
NASA Contractor Or Grantee		
Yes	56.3	153
No	43.8	119

Table 2. Demographic Findings -- U.S. Aerospace Students [N = 640]

Demographics	%	(n)
Major		
Aero/Astronautical Engineering	80.4	499
Civil Engineering	1.3	8
Electrical Engineering	1.4	9
Mechanical Engineering	11.4	71
Other Engineering	0.5	3
Other Major	5.0	31
Citizenship		
U.S.	95.5	595
Other	4.5	28
Class		
Junior	1.1	7
Senior	91.7	574
Graduate Student	6.4	40
Other	0.8	5
Cooperative Education Student		
Yes	16.6	101
No	83.4	506
Student Member of a National Professional Society		<u> </u>
Yes	78.6	462
No	21.4	126
Gender		
Female	16.4	102
Male	83.6	519
NASA Contractor or Grantee		
Yes	15.7	97
No	84.3	519

## Use of Specific Print Sources and Electronic Data Bases

Libraries house a variety of printed information products that are designed to indicate awareness of the existence and availability of information. Certain of these products, such as NASA Scientific and Technical Aerospace Reports (STAR), indicate the availability of aerospace technical reports. As shown in table 5, the aerospace faculty and students in this study make little use of these printed sources of information.

Table 3. Sources Used to Meet the Engineering Information Needs of U.S. Aerospace Faculty and Students

		Us	se		Importance			
	Fac	ulty	Stud	ents	Facu	ılty	Stud	ents
Information Sources	(%)*	(n)	(%)*	(n)	(%)*	(n)	(%)*	(n)
Your Personal Collection of								
Information	94.8	258	67.7	430	94.8	259	74.2	471
University Library	45.0	122	44.0	280	65.2	176	54.7	347
Engineering or Departmental Library	37.3	101	45.5	289	52.5	143	56.9	361
Librarian	8.7	23	12.1	76	23.3	62	21.9	138
Your Personal Contacts Within								
Aerospace Companies	24.5	66	12.6	80	33.6	91	27.0	170
Your Personal Contacts at								
NASA/DoD Labs	25.5	69	9.7	61	40.7	109	22.3	140
Other Students	18.9	51	65.4	416	22.2	60	67.4	427
Faculty Members			54.8	346	<b>-</b> -		72.2	458
Faculty Members at Your University	41.3	112			53.8	146		
Faculty Members at Other	1							
Universities	18.4	49			31.8	86		

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

A number of electronic data bases have been created to facilitate access to the literature. Some of these, such as NASA RECON, are specific to aerospace. Faculty and students were asked to indicate the number of times they used certain online databases during the school year. Use of these data bases ranged from a high of 15% (NTIS Online) to a low of 2% (BRS, Wilson Line, and INSPEC) for faculty and a high of 8% (NTIS Online) to a low of 1% (BRS and INSPEC) for students (table 6).

Librarians and information intermediaries were asked how searches of these online electronic data bases are provided to engineering students on their campus (Pinelli, Barclay, and Kennedy, 1994). Their responses appear in table 7. About 97% of the libraries offer online search services. In libraries that offer search services, about 37% of the students **pay all costs** associated with the search, about 34% of the students **pay a reduced cost** with either the library or engineering department absorbing some of the cost, and about 12% of the students **pay no cost** with either the library or the engineering department absorbing all the cost.

These same library representatives were asked to indicate the library's approach to performing online search services for engineering students (table 8). About 54% indicated that students do all searches through an intermediary; 22% indicated that students do most of their searches

Table 4. Use and Importance of Information Products in Meet the Engineering Information Needs of U.S. Aerospace Faculty and Students

		Us	se			Imp	ortance	
	Fac	culty	Stud	ents	Fac	ulty	Stude	ents
Information Products	(%)*	(n)	(%)*	(n)	(%)*	(n)	(%)*	(n)
Conference/Meeting Papers	73.9	201	44.8	285	80.6	217	48.7	306
Journal Articles	80.0	220	52.0	331	87.0	234	58.2	366
Handbooks	28.8	77	44.4	280	37.5	99	51.2	320
Textbooks	65.9	180	77.3	491	71.3	191		
Computer Programs and								
Documentation	35.2	95	43.7	279	37.4	98	45.8	288
Bibliographic, Numeric, Factual								
Data Bases	11.2	30	20.0	127	18.6	49	24.4	152
Theses/Dissertations	16.1	44			24.0	64	20.1	125
NACA Technical Reports	20.0	55	19.0	119	27.4	73	25.1	156
NASA Technical Reports	37.1	101	50.5	322	49.8	134	54.7	344
DoD Technical Reports	14.1	38	6.8	43	26.0	69	15.7	97
AGARD Technical Reports	10.7	29	5.6	35	18.8	50	11.3	69
Foreign Technical Reports	5.2	14	3.6	23	9.8	26	5.8	36
Technical Translations	3.0	8	3.2	20	7.1	19	7.8	49
Patents	1.1	3	1.1	7	7.5	20	4.2	26
Aerospace Company Technical								
Reports	11.1	30	25.5	162	19.2	51	32.9	207
University Technical Reports	12.2	33	20.5	129	20.9	56	30.5	191
Informal Information Products								
(e.g., Vendor/Supply Catalogs,								
Company Literature, Trade						,		
Journals/Magazines)	23.9	65	24.6	156	22.4	59	34.0	214

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

through an intermediary, 5% indicated that students do half of their searches themselves and half through an intermediary, and about 8% indicated that students do most of their searches themselves.

Faculty and students were asked to indicate how they search online electronic data bases (table 9). About 34% of the faculty and 41% of the students do not use electronic data bases. Of those faculty using them, 82% of the searching is **performed completely or in part by a librarian**. However, 75% of the students who use data bases **do all or most of their own searching**.

Table 5. Print Sources Used to Meet the Engineering Information Needs of U.S. Aerospace Faculty and Students

		Percent Using One or More Times This School Year					
	Fa	culty	Stúdents				
Print Sources	(%)	(n)	(%)	(n)			
ScienceGeneral							
Science Citation Index	36.5	96	8.3	52			
EngineeringGeneral							
Applied Science and Technology Index	32.1,	86	34.4	215			
Engineering Index	42.1	112	34.1	214			
Aerospace							
Government Reports							
Announcement and Index (GRA&I)	28.9	76	29.0	181			
International Aerospace							
Abstracts (IAA)	36.2	96	37.1	232			
NASA SCAN	19.2	50	5.7	35			
NASA SP-7037							
(Aeronautical Engineering: a Continuing Bibliography)	20.0	52	25.1	156			
NASA STAR	33.6	90	20.8	130			

Table 6. Electronic Data Bases Used to Meet the Engineering Information Needs of U.S. Aerospace Faculty and Students

Electronic Sources	Percent Using One or More Times This School Year					
	Fa	Faculty				
	(%)	(n)	(%)	(n)		
General						
DIALOG Including Knowledge Index	7.1	18	2.3	14		
BRS Including After Dark	1.5	4	0.5	3		
Wilson Line Index	2.0	5	8.0	50		
ScienceGeneral						
SCISEARCH	3.6	9	1.4	9		
EngineeringGeneral						
COMPENDEX	3.9	10	1.6	10		
INSPEC	2.4	6	0.5	3		
Aerospace						
AIAA Aerospace Data Base	9.2	23	7.5	46		
DTIC DROLS	3.2	8	1.0	6		
NASA RECON	12.7	32	7.0	44		
NTIS Online	14.7	37	8.2	51		

Table 7. Approaches Used By U.S. Academic Libraries
In Providing Online (Electronic) Searching For U.S. Aerospace Engineering Students

Approach	Percentage	Number
Not Offered	2.9	2
Student Pays Nothing For Service; Library Absorbs All Costs	11.8	8
Student Pays Reduced Cost; Library Absorbs Some of the		
Costs	33.8	23
Student Pays All Costs	36.8	25
Other	14.7	10

Table 8. Approaches Used By U.S. Academic Libraries In Performing Online (Electronic) Searching For U.S. Aerospace Engineering Students

Approach	Percentage	Number
Not Offered	4.5	3
Students Do All Searches		
Students Do Most Searches	7.5	5
Students Do Half of the Searches By Themselves and Half		
Through an Intermediary	4.5	3
Students Do Most Searches Through an Intermediary	22.4	15
Students Do All Searches Through an Intermediary	53.7	36
Other	7.5	5

Table 9. How U.S. Aerospace Faculty and Students Search On-line (Electronic) Data Bases

	Fa	Faculty		idents
Search Method	(%)	(n)	(%)	(n)
I Do Not Use Electronic Data Bases I Do Use Electronic Data Bases	34.1	88	41.4	256
	65.9	170	58.6	363
I Do All Searches Myself I Do Most Searches Myself I Do Half By Myself and Half Through	9.3	24	19.7	122
	15.5	40	24.1	149
a Librarian I Do Most Searches Through a Librarian I Do All Searches Through a Librarian	8.5	22	6.9	43
	10.5	27	4.7	29
	22.1	57	3.2	20

### Use of Computer and Information Technology

Faculty and students make considerable use of computer and information technology although in different proportions (table 10). Faculty use outstrips student use in all categories except for electronic data bases and laser and video disks/CD-ROM products.

Table 10. Use of Computer and Information Technology by U.S. Aerospace Faculty and Students

	Fac	Students		
Technology	(%)*	(n)	(%)*	(n)
Electronic Data Bases Laser and Video Disks/CD-ROM Products Desktop Publishing Electronic Bulletin Boards E-Mail Electronic Networks	18.4 8.5 43.0 13.9 42.4 35.6	48 22 112 36 114 93	25.7 15.5 40.9 6.1 14.0 16.0	160 96 254 38 88 99
Fax/Telex	56.5	153	9.2	58

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

Faculty and students reported substantial use of computer software (table 11). Student use exceeds overall faculty use but most notably in the use of spelling checkers.

Table 11. Use of Computer Software by U.S. Aerospace Faculty and Students

	Fac	culty	Stu		
Software	(%)*	(n)	(%)*	(n)	
Word Processors	87.9	240	96.2	608	
Spelling Checkers	63.4	170	83.5	526	
Thesaurus	28.5	76	35.7	224	
Grammar/Style Checkers	12.3	33	13.8	86	
Outliners/Prompters	8.3	22	10.2	63	
Business Graphics	15.0	40	26.9	167	
Scientific Graphics	65.2	178	71.3	446	

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

### **Use of NASA Technical Reports**

About 37%/51% of the faculty and students use NASA technical reports and about 50%/55% of them indicated that NASA technical reports are important in meeting their engineering information needs (table 4). Survey participants were asked a series of questions regarding NASA technical reports (tables 11, 12, 13, and 14). Faculty participants used, on average, NASA technical reports about 10 times during the school year. Student participants used, on average, NASA technical reports about 8 times during the school year (table 11). NASA technical reports were used in paper format by both faculty and students to a far greater extent than were NASA technical reports in microfiche (table 12).

Table 11. Use of NASA and AGARD Technical Reports by U.S. Aerospace Faculty and Students

	Mean (Median) Number of Times Used This School Year			
Reports	Faculty	Students		
NASA Technical Reports AGARD Technical Reports	9.8 (5.0) 2.9 (0.0)	8.4 (5.0) 0.7 (0.0)		

Table 12. Use of NASA Technical Reports by U.S. Aerospace Faculty and Students in Paper and Microfiche Format

	Mean (Media	Mean (Median) Percentage in Paper or Microfiche					
	Facu	ılty	Stud	lents			
Reports	Paper	Microfiche	Paper	Microfiche			
NASA Technical Reports	78.9 (100.0)	10.8 (0.0)	62.5 (80.0)	24.8 (0.0)			

Survey participants were asked to indicate the problems (if any) they encountered in their attempts to obtain and use NASA technical reports (tables 13 and 14). The problems encountered in obtaining NASA technical reports were the same for both faculty and students. With one exception, however, problems were encountered to a greater extent by students than by faculty. In order of occurrence, the problems were (1) the library didn't own the report, (2) the report had to be obtained from either NTIS or NASA, (3) the library owned the report but it was missing, and (4) the library owned the report but it was stored some place else on campus. About 10% of the faculty reported "illegible microfiche" and "intellectual quality of the research" as problems encountered using NASA technical reports. About 16% of the students reported "illegible

graphics" (e.g., charts, photos, and figures) and about 13% reported "intellectual quality of the research" as problems encountered in using NASA technical reports.

Table 13. Problems Encountered by U.S. Aerospace Faculty and Students
Obtaining NASA Technical Reports

	Fa	culty	Stu	dents
Problem	(%)*	(n)	(%)*	(n)
The Library Didn't Own The Report	34.7	93	43.4	271
The Library Owned The Report But It Was Missing	16.7	45	22.2	139
The Library Owned The Report But It Stored Some				
Place Else On Campus	10.8	29	14.0	87
The Library Staff Was Not Cooperative Or Helpful In				
Getting The Report	3.7	10	7.5	47
The Report Was Classified Or Restricted	5.7	15	7.8	48
The Report Was Available Only To U.S. Citizens	4.6	12	3.1	19
The Report Had To Be Obtained From NTIS Or	25.5	67	20.3	126
NASA				

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

Table 14. Problems Encountered by U.S. Aerospace Faculty and Students Using NASA Technical Reports

	Fac	Students		
Problem	(%)*	(n)	(%)*	(n)
Illegible Microfiche	10.3	27	8.4	52
Illegible Text	6.1	16	7.1	44
Illegible Graphics (e.g., Charts, Photos, Figures)	8.8	23	15.6	97
Poor Report Organization/Format/Presentation	6.3	16	6.5	40
Intellectual Quality Of The Research	10.3	24	12.5	75

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

Rating NASA Technical Reports. Faculty and student participants were asked to rate NASA technical reports according to 10 factors. A 1 to 5 point scale with "1" being the lowest possible rating and "5" being the highest possible rating was used to rate each factor. The responses appear in table 15.

Table 15. Rating NASA Technical Reports By U.S. Aerospace Faculty and Students

	Overall Mean <sup>a</sup> (Number) Rating of Each Factor By			
Factors	Faculty	Students		
Accessibility	3.4 (221)	3.5 (274)		
Ease of Use	3.7 (227)	3.0 (271)		
Expense	3.7 (193)	2.3 (270)		
Familiarity or Experience	3.6 (188)	3.1 (274)		
Technical Quality or		, ,		
Reliability	3.9 (224)	3.2 (270)		
Comprehensiveness	3.6 (226)	3.1 (271)		
Relevance	3.6 (225)	3.5 (269)		
Physical Proximity	3.2 (209)	3.2 (269)		
Skill in Use	3.5 (199)	2.9 (271)		
Timeliness	3.4 (188)	3.0 (268)		

<sup>&</sup>lt;sup>a</sup> A 1 to 5 point scale was used to rate each factor with "1" being the lowest possible rating and "5" being the highest possible rating; hence, the higher the average (mean), the higher the rating of the factor.

Aerospace engineering faculty rated NASA technical reports highest in terms of (1) technical quality or reliability  $(\overline{X} = 3.9)$ , (2) ease of use  $(\overline{X} = 3.7)$ , (3) expense  $(\overline{X} = 3.7)$ , (4) comprehensiveness  $(\overline{X} = 3.6)$ , (5) relevance  $(\overline{X} = 3.6)$ , and (6) familiarity or experience  $(\overline{X} = 3.6)$ . Aerospace engineering students rated NASA technical reports highest in terms of (1) accessibility  $(\overline{X} = 3.5)$ , (2) relevance  $(\overline{X} = 3.5)$ , (3) technical quality or reliability  $(\overline{X} = 3.2)$ , (4) physical proximity  $(\overline{X} = 3.2)$ , and (6) familiarity or experience  $(\overline{X} = 3.1)$ .

U.S. academic librarians and technical information specialists were asked to rate NASA technical report according to the same 10 factors. Their responses, which appear in table 16, are compared with the aerospace engineering faculty and student data contained in table 15. Academic librarians rated NASA technical reports highest in terms of accessibility ( $\bar{X} = 4.2$ ), relevance ( $\bar{X} = 4.2$ ), and familiarity or experience ( $\bar{X} = 3.9$ ).

Although higher overall, the academic librarians' ratings more closely approximate the aerospace engineering students' ratings. Both groups rated NASA technical reports highest for accessibility and relevance, followed by familiarity or experience for the librarians and technical quality or reliability for the students. The three factors rated highest by the librarians are not the same as those rated highest by the aerospace engineering faculty.

Table 16. Rating of NASA Technical Reports By U.S. Aerospace Faculty and Students and U.S. Academic Librarians

	Overall Mean <sup>a</sup> (Number) Rating Of Factors By				
Factors	Faculty	Students	Librarians		
Accessibility	3.4 (221)	3.5 (274)	4.2 (64)		
Ease Of Use	<b>3.7</b> (227)	3.0 (271)	3.4 (61)		
Expense	<b>3.7</b> (193)	2.3 (270)	3.0 (62)		
Familiarity Or Experience	3.6 (188)	3.1 (274)	3.9 (62)		
Technical Quality Or Reliability	3.9 (224)	<b>3.2</b> (270)	3.8 (55)		
Comprehensiveness	3.6 (226)	3.1 (271)	3.7 (56)		
Relevance	3.6 (225)	3.5 (269)	4.2 (57)		
Physical Proximity	3.2 (209)	3.2 (269)	3.8 (61)		
Skill In Use	3.5 (199)	2.9 (271)	3.6 (57)		
Timeliness	3.4 (188)	3.0 (268)	3.7 (57)		

<sup>&</sup>lt;sup>a</sup> A 1 to 5 point scale was used to rate each factor with "1" being the lowest possible rating and "5" being the highest possible rating; hence, the higher the average (mean), the higher the rating of the factor.

### Use of Selected NASA Information in Electronic Format

Survey participants were asked to indicate how likely they would be to use selected aerospace information in electronic format (table 17). Likely use was measured on a 1 to 5 point scale with "5" being the "most likely" to use and "1" being the "least likely" to use. Aerospace engineering students indicated a greater willingness to use all of the selected aerospace information in electronic format than did their faculty counterparts. Aerospace engineering faculty reported the highest "willingness to use" scores for (1) an online system (full text and graphics) for NASA technical reports (62.9%) followed by full text of NASA technical reports on CD-ROM (61.9%) and STAR on CD-ROM (56.3%). Aerospace engineering students reported the highest "willingness to use" scores for (1) an online system (full text and graphics) for NASA technical reports (79.7%) followed by full text of NASA technical reports on CD-ROM (77.1%) and STAR on CD-ROM (70.5%).

### **Library and Technical Information Instruction**

Survey participants were asked if they had received instruction in (1) the use of engineering information resources and materials, (2) the use of the library, (3) technical writing, (4) oral presentations, and (5) searching online (electronic) data bases (table 18). Those students receiv-

Table 17. Likely Use of Selected Aerospace Information in Electronic Format by U.S. Aerospace Faculty and Students

	Fa	eculty	Students	
Selected Information	(%)*	(n)	(%)*	(n)
STAR on CD-ROM	56.3	98	70.5	246
Full Text of NASA Reports on CD-ROM	61.9	125	77.1	353
Computer Program Listing on CD-ROM	45.3	87	64.1	283
Numerical/Factual Data on CD-ROM	42.7	81	66.8	292
Images (Photographs)on CD-ROM	39.2	76	68.9	320
Online System (Full Text and Graphics) for				
NASA Technical Reports	62.9	131	79.7	385

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale with "1" being "most likely" to use.

ing the instruction were asked to indicate if the instruction was credit/non-credit, required/elective, or part of an engineering/separate course.

Table 18. Instruction of U.S. Aerospace Engineering Students

	_	eering ces and crials	Departn Engine Library	ering	1	nnical iting	Ora Presenta		On (Elec	ching lline tronic) Bases
Instruction	%*	(n)	%*	(n)	%*	(n)	<b>%</b> *	(n)	%*	(n)
Instruction Received	42.4	265	51.7	321	73.4	461	78.2	491	32.8	204
Instruction Was										
A Credit Course	20.0	53	18.4	59	69.8	322	61.3	301	14.7	30
A Non-Credit Course	3.4	9	5.9	19	1.5	7	4.7	23	7.4	15
A Required Course	15.1	40	17.1	55	61.2	282	48.1	230	10.3	21
An Elective Course	4.2	11	3.4	11	9.1	42	13.0	64	5.9	12
Part of an Engineering		i						İ		
Course	58.1	154	43.6	140	41.0	189	50.3	247	25.5	52
Part of Another Course	14.7	39	21.2	68	13.7	63	24.8	122	25.0	51
A Separate Course	1.9	5	2.5	8	28.2	130	15.3	75	3.4	7

<sup>\*</sup>Percentages do not total 100 because students could select more than one response.

Engineering Information Resources Instruction. Forty-two percent of the student participants indicated that they had received engineering information resources and materials

instruction. For most of them, the instruction was (1) taken for credit, (2) required, and (3) taken as part of an engineering course.

<u>Library Instruction</u>. About 52% of the students indicated that they had received instruction in the use of the departmental/engineering library. For most of them, the instruction was (1) taken for credit, (2) required, and (3) taken as part of an engineering course.

<u>Technical Writing</u>. Seventy-three percent of the students indicated that they had received technical writing instruction. For most of them, the instruction was (1) taken for credit, (2) required, and (3) taken as part of an engineering course.

<u>Oral Presentations</u>. Seventy-eight percent of the students indicated that they had received instruction in preparing/giving oral presentations. For most of them, the instruction was (1) taken for credit, (2) required, and (3) taken as part of an engineering course.

<u>Data Base Searching</u>. About 33% of the students indicated that they had received instruction in searching online (electronic) data bases. For most of them, the instruction was (1) taken for credit, (2) required, and (3) taken as either part of an engineering course or as part of another course.

### Importance of Capabilities

Faculty and student participants were asked to indicate how important they thought (1) the ability to communicate technical information effectively and (2) a knowledge of engineering information resources would be to the professional success of students. Their responses appear in table 19. There is considerable agreement about the importance of the two abilities to professional success in aerospace engineering. It is noteworthy that while both faculty and students agree upon the importance of these abilities, less than half (42.4%) of the student received engineering information resources and materials instruction and about three-quarters (73.4%/78.2%) received technical writing instruction and instruction in preparing/giving oral presentations.

Table 19. The Importance of Two Abilities to Professional Success: U.S. Aerospace Engineering Faculty and Students Perspectives

	Fac	culty	Students	
Factor	(%)*	(n)	(%)*	(n)
Ability to Communicate Technical Information Effectively Knowledge of Engineering Information Resources	98.5 91.9	266 249	97.4 89.5	596 541

<sup>\*</sup>The percentages report combined "1" and "2" responses on a 5 point scale.

#### **FINDINGS**

- 1. The "average" aerospace engineering faculty participant in this study is male, tenured, and holds the rank of professor; has a doctorate; belongs to the AIAA, has 15 years of professional academic aerospace work experience; is a NASA grantee or contractor, and is a U.S. citizen.
- 2. The "average" aerospace engineering student participant in this study is male, is majoring in either aeronautics or astronautics, is a U.S. citizen, is a student member of a national professional society, and is/was not a cooperative education student.
- 3. The sources used to meet the information needs of aerospace engineering faculty include (1) personal collection of information, (2) the university library, (3) other faculty members, (4) the engineering or departmental library, and (5) personal contacts at NASA and DoD labs.
- 4. The sources used to meet the information needs of aerospace engineering students include (1) personal collections of information, (2) other students, (3) faculty members, (4) the engineering or departmental library, and (5) the university library.
- 5. The information products used to meet the information needs of aerospace engineering faculty include (1) journal articles, (2) conference-meeting papers, (3) textbooks, (4) NASA technical reports, and (5) computer programs and documentation.
- 6. The information products used to meet the information needs of aerospace engineering students include (1) textbooks (2) journal articles, (3) NASA technical reports, (4) conference-meeting papers, and (5) handbooks.
- 7. The print sources used most often to meeting the information needs of aerospace engineering faculty include (1) Engineering Index, (2) Science Citation Index, and (3) International Aerospace Abstracts.
- 8. The print sources used most often to meeting the information needs of aerospace engineering students include (1) International Aerospace Index, (2) Applied Science and Technology Index, and (3) Engineering Index.
- 9. In those academic libraries surveyed, aerospace engineering students pay all costs or a reduced cost for searching online (electronic) data bases.
- 10. In those academic libraries surveyed, all or most searches of online (electronic) data bases performed for aerospace engineering students are done by an information intermediary.
- 11. About 66%/59% of aerospace engineering faculty and students do not use (search) online (electronic) data bases. About 25%/44% of the aerospace engineering faculty and students indicated that they searched or did most of their own searches of online (electronic) data bases when they used them.

- 12. Aerospace engineering faculty and students made the greatest use of desktop publishing and E-Mail, and desktop publishing and electronic data bases respectively.
- 13. Aerospace engineering faculty and students made the greatest use of word processors and scientific graphics, and word processors and spelling checkers, respectively.
- 14. Paper copies of NASA technical reports were used about 10/9 times, respectively, by aerospace engineering faculty and students during the school year. The "library did not own the report" was the problem most frequently encountered by aerospace engineering faculty and students trying to obtain a NASA technical report.
- 15. The problems most often encountered by aerospace engineering faculty and students using NASA technical reports included illegible microfiche, illegible graphics, and the intellectual quality of the research.
- 16. Aerospace engineering faculty rated NASA technical reports highest for (1) technical quality or reliability, (2) ease of use, and (3) expense. Aerospace engineering students rated NASA technical reports highest for (1) accessibility, (2) relevance, (3) and technical quality or reliability. Academic librarians rated NASA technical reports highest for (1) accessibility, (2) relevance, and (3) familiarity or experience.
- 17. Aerospace engineering faculty recorded the highest "willingness to use" scores for (1) an online system (full text and graphics) for NASA technical reports followed by full text of NASA technical reports on CD-ROM and *STAR* on CD-ROM.
- 18. Aerospace engineering students scored the highest "willingness to use" scores for an online system (full text and graphics) for NASA technical reports followed by full text of NASA technical reports on CD-ROM and STAR on CD-ROM.
- 19. A simple majority of aerospace engineering students surveyed had received instruction in using a departmental or engineering library, technical writing, and oral presentations.
- 20. There was considerable agreement among aerospace engineering faculty and students regarding the importance of the "ability to communicate technical information effectively" and the "knowledge of engineering information resources" to professional (engineering) success.

### **CLOSING REMARKS**

The U.S. aerospace industry depends on U.S. colleges and universities to provide a technically skilled workforce. The U.S. aerospace industry considers the information use and communications skills of new engineers to be very important; therefore, the ability of aerospace engineers to gather and use STI effectively becomes important both to their personal success and the competitive success of the U.S. aerospace industry. In addition, the continuing competitive

success of the U.S. aerospace industry requires a skilled workforce that has access to the best and most current STI. The results reported herein represent an important first step toward understanding the communications practices of U.S. academic engineering faculty and students within the large context of the aerospace knowledge diffusion process.

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### APPENDIX A

# NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

### **Fact Sheet**

The process of producing, transferring, and using scientific and technical information (STI), which is an essential part of aerospace research and development (R&D), can be defined as Aerospace Knowledge Diffusion. Studies tell us that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills. These same studies indicate, however, that we know little about aerospace knowledge diffusion or about how aerospace engineers and scientists find and use STI. To learn more about this process, we have organized a research project to study knowledge diffusion. Sponsored by NASA and the Department of Defense (DoD), the NASA/DoD Aerospace Knowledge Diffusion Research Project is being conducted by researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute. This research is endorsed by several aerospace professional societies including the AIAA, RAeS, and DGLR and has been sanctioned by the AGARD and AIAA Technical Information Panels.

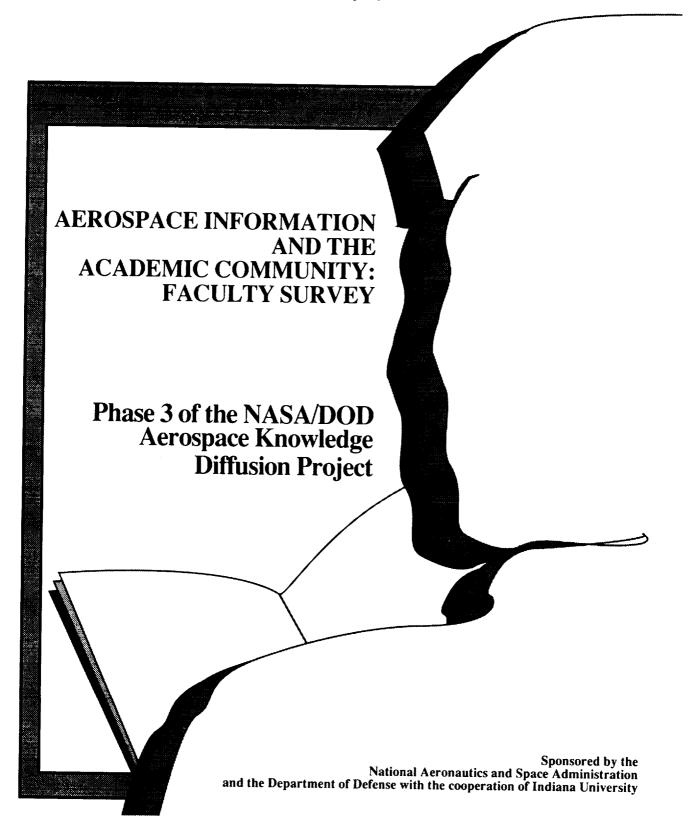
This 4-phase project is providing descriptive and analytical data about the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists, in particular their use of government-funded aerospace STI. Phase 2 examines the industry-government interface and emphasizes the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and emphasizes the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behaviors of non-U.S. aerospace engineers and scientists from Western European nations, India, Israel, Japan, and the former Soviet Union.

The results of this research project will help us to understand the flow of STI at the individual, organizational, national, and international levels. The findings can be used to identify and correct deficiencies; to improve access and use; to plan new aerospace STI systems: and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. These results will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. The results of our research are being shared freely with those who participate in the study.

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### APPENDIX B

### Phase 3 Faculty Questionnaire



## These data will help us determine the use and importance of information by engineering faculty.

1. How frequently during this past year did you use the following information sources to meet your engineering information needs? (Circle number)

Frequently					Not Available
Γ					
Your personal collection of information1	2	3	4	5	9
University library1	2	3	4	5	9
Engineering or departmental library1	2	3	4	5	9
Librarian1	2	3	4	5	9
Your personal contacts within aerospace companies	2	3	4	5	9
Your personal contacts at NASA/DOD labs	2	3	4	5	9
Faculty members at your university1	. 2	3	4	5	9
Faculty members at other universities1	2	3	4	5	9
Students	2	3	4	5	9

2. How frequently during this past year did you use the following information products to meet your engineering information needs? (Circle number)

Frequently					Never	Not Available
	Γ					
Conference/meeting papers	1	2	3	4	5	9
Journal articles	1.	2	3	4	5	9
Handbooks	1	2	3	4	5	9
Textbooks	1	2	3	4	5	9
Computer programs and documentation	1	2	3	4	5	9
Bibliographic, numeric, factual databases	.1	2	3	4	5	9
Theses/dissertations	. 1	2	3	4	5	9
NACA reports	. 1	2	3	4	5	9
NASA reports	. 1	2	3	4	5	9

### Frequency of use

Frequently				Not Available
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
2	3	4	5	9
	2 2 2 2 2 2 2	2 3 2 3 2 3 2 3 2 3 2 3 2 3 2 3	2 3 4 2 3 4	2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5 2 3 4 5

## 3. How important are the following information sources in meeting your engineering information needs? (Circle number)

Very Important				Not at all Important	Not Available
	<del>-</del> 1				
Your personal collection of information	2	3	4	5	9
University library1	2	3	4	5	9
Engineering or departmental library1	2	3	4	5	9
Librarians1	2	3	4	5	9
Your personal contacts within aerospace companies	2	3	4	5	9
Your personal contacts at NASA/DOD labs1	2	3	4	5	9
Faculty members at your university1	2	3	4	5	9
Faculty members at other universities	2	3	4	5	9
Students 1	2	3	4	5	9

4. How important are the following information products in meeting your engineering information needs? (Circle number)

Very Important			Not at all Important	Not Available	
Conference/meeting papers1	2	3	4	5	9
Journal articles1	2	3	4	5	9
Handbooks1	2	3	4	5	9
Textbooks 1	2	3	4	5	9
Computer programs and documentation	2	3	4	5	9
Bibliographic, numeric, factual databases1	2	3	4	5	9
Theses/dissertations1	2	3	4	5	9
NACA reports1	2	3	4	5	9
NASA reports1	2	3	4	5	9
DOD reports1	2	3	4	5	9
AGARD reports1	2	3	4	5	9
Foreign technical reports1	2	3	4	5	9
Technical translations1	2	3	4	5	9
Patents1	2	3	4	5	9
Aerospace company technical reports1	2	3	4	5	9
University technical reports1	2	3	4	5	9
Informal information products (e.g., vendor/ supply catalogs, company literature, trade journals/magazines)1	2	3	4	5	9

5. Approximately how many times during this past year did you use the following print sources in meeting your engineering information needs?

PRINT SOURCES	Times this Past Year	Not Familiar With (🗸
Applied Science and Technology Index		( )
Engineering Index		( )

#### **PRINT SOURCES**

	Times this Past Year	Not Familiar With (&
Government Reports Announcement and Index		()
International Aerospace Abstracts		( )
NASA SP-7037 (Aeronautical Engineering-A Continuing Bibliography With Indexes)		( )
NASA SCAN		( )
NASA STAR		( )
Science Citation Index		( )

### These data will help us determine the use of information technology by engineering faculty.

Approximately how many times this past year have you used the following **electronic** sources in meeting your engineering information needs?

ONLINE (ELECTRONIC) DATABASES	Times this Year	Not Familiar With (&
Aerospace Database		( )
COMPENDEX		( )
DTIC DROLS		( )
INSPEC	<u> </u>	( )
NASA RECON	<del></del>	( )
NTIS Online		( )
SCISEARCH		( )
Wilson Line Index		( )
BRS including "After Dark"	<del></del>	( )
DIALOG including "Knowledge Index"		( )

Which of the following best characterizes your use of online electronic databases? (Circle number) 7.

<sup>1</sup> I do all searches myself2 I do most searches myself

#### Online electronic databases

3 I do half by myself and half through a librarian
4 I do most searches through a librarian
5 I do all searches through a librarian
6 I do not use electronic databases

8. How likely would you be to use the following if they were provided in electronic format? (Circle number)

	Very Likely				Not at all Likely	Don't Know
NASA STAR on CD-ROM	1	2	3	4	5	9
Full text of NASA Technical Reports on CD-ROM	1	2	3	4	5	9
NASA Computer Program Listings on CD-ROM	1	2	3	4	5	9
NASA Numerical/Factual Data on CD-ROM	1	2	3	4	5	9
NASA Photographs (Images) on CD-ROM	1	2	3	4	5	9
Online system with full text and graphics for NASA technical reports	1	2	3	4	5	9

9. How frequently during this past year did you use the following computer applications? (Circle number)

Frequently					Not Available
		· - T	1		
Electronic databases1	2	3	4	5	9
Laser/Video Disc/CD-ROM1	2	3	4	5	9
Desktop/electronic publishing1	2	3	4	5	9
Electronic bulletin boards1	2	3	4	5	9
Electronic Mail1	2	3	4	5	9
Electronic networks 1	2	3	4	5	9
FAX/TELEX 1	2	3	4	5	9

	Frequentl	у			Never	Not Available
	Word Processing	2	3	4	5	9
	Spelling Checkers 1	2	3	4	5	9
	Thesaurus1	2	3	4	5	9
	Grammar and Style Checkers1	2	3	4	5	9
	Outliners and Prompters 1	2	3	4	5	9
	Business Graphics 1	2	3	4	5	9
	Scientific Graphics1	2	3	4	5	9
<b>The</b> 11.	next few questions will help us gather specific information.  About how many times this past year did you use a N.				ARD techn	
					ARD techn	
	next few questions will help us gather specific information.  About how many times this past year did you use a National Times used a NASA report				ARD techn	
	About how many times this past year did you use a N.				ARD techn	
	About how many times this past year did you use a N. Times used a NASA report	ASA techr	ical repor	t? An AC	ARD techn	
11.	About how many times this past year did you use a N. Times used a NASA report  Times used an AGARD report	ASA techr	ical repor	t? An AC	ARD techn	
11.	About how many times this past year did you use a N. Times used a NASA report  Times used an AGARD report  What percentage of the NASA technical reports you	ASA techr	ical repor	t? An AC	ARD techn	
11.	About how many times this past year did you use a N. Times used a NASA report  Times used an AGARD report  What percentage of the NASA technical reports you paper%	ASA techr	ical repor	t? An AC	GARD techn	ical report?

OBTAINING NASA TECHNICAL REPORTS	Frequentl	у	Never	Not Applicable		
The library didn't own the report	1	2	3	4	5	9
The library owned the report but it was missing	1	2	3	4	5	9
The library owned the report but it was stored some place else on campus	1	2	3	4	5	9
The library staff was not cooperative or helpful in getting me the report	1	2	3	4	5	9

## OBTAINING NASA TECHNICAL REPORTS

Frequently	Never	Not Applicable			
The report was classified or restricted1	2	3	4	5	9
The report was available only to U.S. citizens1	2	3	4	5	9
The report had to be obtained from either NTIS or NASA1	2	3	4	5	9
Other (specify)					

USING NASA TECHNICAL REPORTS	Frequently				Never	Not Applicable
		<u> </u>				
Illegible microfiche	1	2	3	4	5	9
Illegible text	1	2	3	4	5	9
Illegible graphics (e.g., charts, photos, figures)	1	2	3	4	5	9
Poor report organization/ format/presentation	1	2	3	4	5	9
Intellectual quality of the research	1	2	3	4	5	9
Other (specify)						

## 14. How would you rate NASA technical reports on each of the following factors?

Excellent	Poor	Don't Know			
<u> </u>					
ACCESSIBILITY: the ease of getting to the information source1	2	3	4	5	9
EASE OF USE: the ease of comprehending or utilizing the information	2	3	4	5	9
EXPENSE: low cost in comparison to other information sources	2	3	4	5	9
FAMILIARITY OR EXPERIENCE: prior knowledge or previous use of the information source1	2	3	4	5	9

#### Rate NASA Technical Reports

	Poor	Don't Know				
TECHNICAL QUALITY OR RELIABILITY: the information was expected to be the best in terms		1	<del>-  </del>	<del></del>		
of quality, accuracy and reliability	1	2	3	4	5	9
COMPREHENSIVENESS: the expectation the information source would provide broad coverage of the available knowledge	1	2	3	4	5	9
RELEVANCE: the expectation that a high percentage of the information retrieved from the source would be used	1	2	3	4	5	9
PHYSICAL PROXIMITY: the distance to the information source	1	2	3	4	5	9
SKILL IN USE: the level of skill or skill mastery required to use the information source	1	2	3	4	5	9
TIMELINESS: the time allocated or available to produce a solution	1	2	3	4	5	9

## The next group of questions asks about the importance of certain skills for professional success.

15. How important do you think it is for the professional success of **your engineering students** to communicate technical information effectively? (Circle number)

Very Important				Not at all Important	Don't Know
	T				
1	2	3	4	5	9

16. How important do you think it is for the professional success of **your engineering students** to have an understanding and knowledge of engineering information resources and materials? (Circle number)

Very Important		Not at all Important	Don't Know		
	T				
1	2	3	4	5	9

Finally, we would like to collect some background information that will help us analyze the data.

17.	Gender:	
	1 Female	2 Male
18.	U.S. Citizen:	
	1 Yes	2 No
19.	Highest level of education completed:	
	1 No degree	5 MBA
	2 Technical or Vocational degree	6 JD
	3 Bachelor's Degree	7 PhD or Sc.D. in
	4 Master's Degree	8 Post Doctorate
		9 Other (specify)
20.	Were you trained as:	
	1 An Engineer	
	2 A Scientist	
	3 Other (specify)	
21.	Do you hold a faculty position:	
	1 Yes	2 No Please skip to Q23.
	Rank held: 1 Professor	4 Adjunct
	2 Associate	5 Instructor
	3 Assistant	6 Other (specify)
22.	Tenured:	
	1 Yes	
	2 No	
	9 Not applicable	

23.	"Advanced Engineering Design Program"? (	or DOD grant or contract, other than the USRA (Circle number)
	1 Yes 2 No	
24.	Years of professional work experience in aer	rospace:
	Academia (or non-profit)	
	Government	
	Industry	
	Total years	
25.	Professional Membership (Circle all that app	oly)
	1 AIAA	5 Other scientific, engineering
	2 ASME	or technical society
	3 IEEE	6 Not a member of any scientific, engineering, or technical society
	4 SAE	engineering, or teerinical society
26.	During the past 3 years, have you authored or	r co-authored any NASA technical reports?
	1 Yes — How many	<u> </u>
27.	During the past 3 years, have you attended N	JASA sponsored or co-sponsored conferences or workshops?
	1 Yes — How many	
28.	In performing your duties as a faculty member NASA personnel?	er during the past year, have you contacted or been contacted by
	1 Yes → How many	<del></del>

**OVER** 

## OPTIONAL QUESTIONS

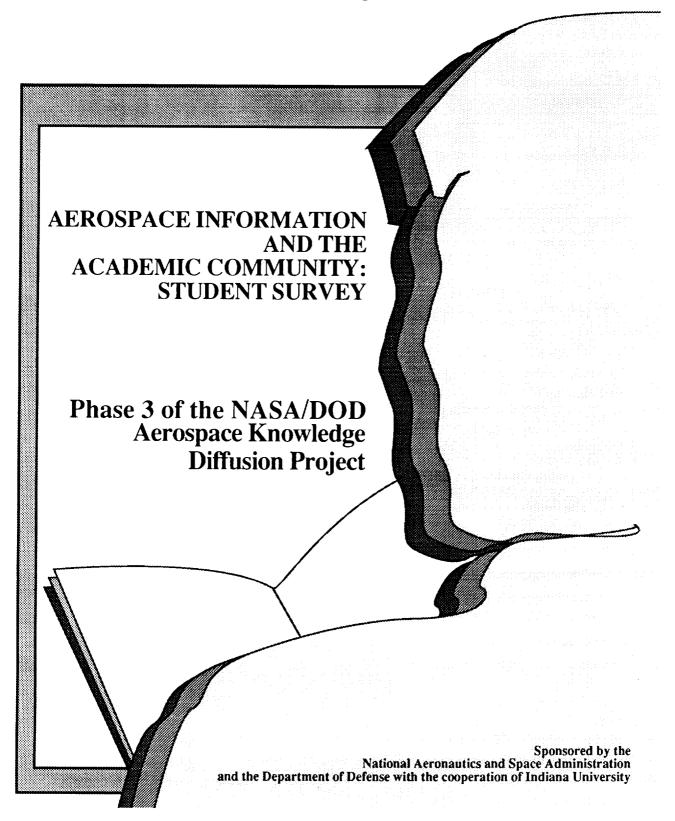
Vhat sugge:	stions can you offer for improving faculty access to the results of NASA research?
s there any	thing else you would care to say regarding this research?

Mail to:

Center for Survey Research 1022 East Third Street Indiana University Bloomington, IN 47405

## **APPENDIX C**

## **Phase 3 Student Questionnaire**



These data will help us determine the use and importance of information by engineering students.

1. How frequently during this past year did you use the following information sources to meet your engineering information needs? (Circle numbers)

Frequently					Never	Not Available
				<del>- T</del>		
Your personal collection of information	1	2	3	4	5	9
University library	1	2	3	4	5	9
Engineering or departmental library	1	2	3	4	5	9
Librarian	1	2	3	4	5	9
Your personal contacts within aerospace companies	1	2	3	4	5	9
Your personal contacts at NASA/DOD labs	1	2	3	4	5	9
Faculty members	1	2	3	4	5	9
Other students	1	2	3	4	5	9

2. How frequently during this school year did you use the following information products to meet your engineering information needs? (Circle numbers)

Frequentl	у			Never	Not Available
	1				
Conference/meeting papers1	2	3	4	5	9
Journal articles1	2	3	4	5	9
Handbooks1	2	3	4	5	9
Textbooks1	2	3	4	5	9
Computer programs and documentation1	2	3	4	5	9
Bibliographic, numeric, factual databases1	2	3	4	5	9
NACA reports1	2	3	4	5	9

#### Frequency of use

Frequently					Not Available	
		1				
NASA reports1	2	3	4	5	9	
DOD reports1	2	3	4	5	9	
AGARD reports1	2	3	4	5	9	
Foreign technical reports1	2	3	4	5	9	
Technical translations1	2	3	4	5	9	
Patents 1	2	3	4	5	9	
Aerospace company technical reports	2	3	4	5	9	
University technical reports1	2	3	4	5	9	
Informal information products (e.g., vendor/supply catalogs, company literature, trade journals/magazines)	2	3	4	5	9	

# 3. How important are the following information sources in meeting your engineering information needs? (Circle numbers)

Very Important				Not at all Important	Not Available
Variation of the North Control			I		
Your personal collection of information	2	3	4	5	9
University library1	2	3	4	5	9
Engineering or departmental library1	2	3	4	5	9
Librarians1	2	3	4	5	9
Your personal contacts within aerospace companies	2	3	4	5	9
Your personal contacts at NASA/DOD labs1	2	3	4	5	9
Faculty members1	2	3	4	5	9
Other Students1	2	3	4	5	9

4. How important are the following information products in meeting your engineering information needs?

(Circle numbers)

(Circle numbers)	Very Important				Not at all Important	Not Available
			1			
Conference/meeting papers	1	2	3	4	5	9
Journal articles	1	2	3	4	5	9
Handbooks	1	2	3	4	5	9
Computer programs and documentation	1	2	3	4	5	9
Bibliographic, numeric, factual databases	1	2	3	4	5	9
Theses/dissertations	1	2	3	4	5	9
NACA reports	1	2	3	4	5	9
NASA reports	1	2	3	4	5	9
DOD reports	1	2	3	4	5	9
AGARD reports	1	2	3	4	5	9
Foreign technical reports	1	2	3	4	5	9
Technical translations	1	2	3	4	5	9
Patents	1	2	3	4	5	9
Aerospace company technical reports	1	2	3	4	5	9
University technical reports	1	2	3	4	5	9
Informal information products (e.g., vendor/supply catalogs, company literature, trade journals/magazines)	1	2	3	4	5	9

5. Approximately how many times during this school year have you used the following print sources in meeting your engineering information needs?

PRINT SOURCES	Times This School Year	Not Familiar With (		
Applied Science and Technology Index		()		
Engineering Index	<u> </u>	( )		

#### **PRINT SOURCES**

	Times This School Year	Not Familiar With (🗹
Government Reports Announcement and Index		( )
International Aerospace Abstracts		( )
NASA SP-7037 (Aeronautical Engineering A Continuing Bibliography With Indexes)		( )
NASA SCAN		( )
NASA STAR		()
Science Citation Index		( )

These data will help us determine the use of information technology by engineering students.

6. Approximately how many times during this school year did you use the following electronic sources in meeting your engineering information needs?

ONLINE (ELECTRONIC) DATABASES	Times this School Year	Not Familiar With ( 🗸
Aerospace Database		( )
COMPENDEX		( )
DTIC DROLS		( )
INSPEC	<del></del>	( )
NASA RECON	<del></del>	( )
NTIS Online	<del></del>	( )
SCISEARCH	<del></del>	( )
Wilson Line Index		( )
BRS including "After Dark"	<del></del>	( )
DIALOG including "Knowledge Index"	<del></del>	( )

- Which of the following best characterizes your use of online electronic databases? (Circle number) 7.
  - 1 I do all searches myself
  - 2 I do most searches myself
  - 3 I do half by myself and half through a librarian
    4 I do most searches through a librarian
    5 I do all searches through a librarian
    6 I do not use electronic databases
- How likely would you be to use the following if they were provided in electronic format? (Circle numbers)

Very Likely			Not at all Likely	Don't Know	
NASA STAR on CD-ROM1	2	3	4	5	9
Full text of NASA Technical Reports on CD-ROM1	2	3	4	5	9
NASA Computer Program Listings on CD-ROM1	2	3	4	5	9
NASA Numerical/Factual Data on CD-ROM1	2	3	4	5	9
NASA Photographs (Images) on CD-ROM1	2	3	4	5	9
Online system with full text and graphics for NASA technical reports	2	3	4	5	9

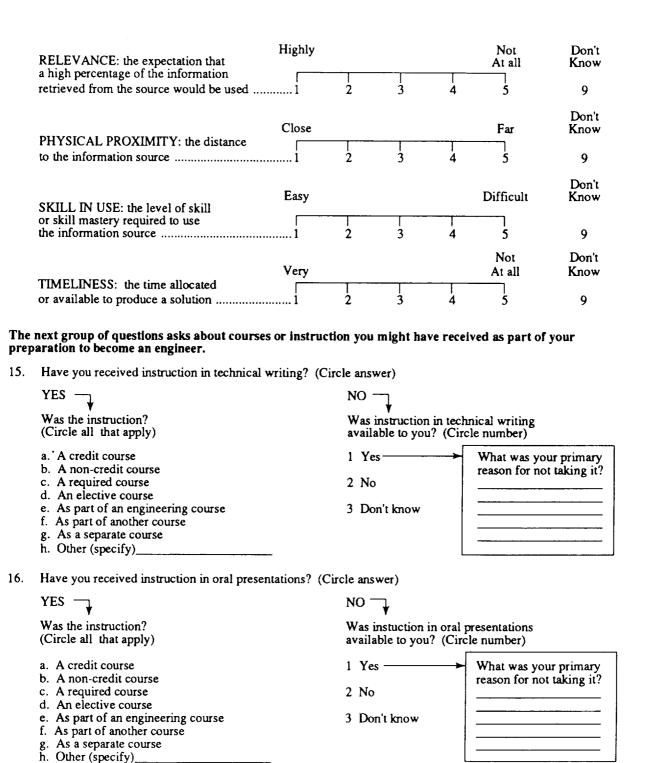
How frequently during this school year did you use the following computer applications? (Circle numbers)

Frequently					Not Available
Electronic databases1	2	3	4	5	9
Laser/Video Disc/CD-ROM1	2	3	4	5	9
Desktop/electronic publishing1	2	3	4	5	9
Electronic bulletin boards1	2	3	4	5	9
Electronic Mail1	2	3	4	5	9
Electronic networks1	2	3	4	5	9
FAX/TELEX1	2	3	4	5	9

10.	How frequently during this school year have	•	ie follov	ving softw	are? (Ci		Not
		Frequently				Never	Available
			T		T	]	
	Word Processing	1	2	3	4	5	9
	Spelling Checkers	1	2	3	4	5	9
	Thesaurus	1	2	3	4	5	9
	Grammar and Style Checkers	1	2	3	4	5	9
	Outliners and Prompters	1	2	3	4	5	9
	Business Graphics	1	2	3	4	5	9
	Scientific Graphics	1	2	3	4	5	9
<b>The</b> 11.	next few questions will help us gather spec About how many times this school year did						•
	Times used a NASA report		Times	used an A	AGARD	report	
12.	What percentage of the NASA technical rep	orts <b>you</b> us	ed in the	school y	ear were	in:	
	paper%		micro	fiche	%	)	
13.	During this school year, how frequently did	you encoun	ter the fe	ollowing p	oroblems:	(Circle nur	nbers)
	OBTAINING NASA TECHNICAL REPORTS	Frequently				Never	Not Applicable
	The library didn't own the report	1	2	3	4	5	9
	The library owned the report but it was missing	1	2	3	4	5	9
	The library owned the report but it was stored some place else on campus	1	2	3	4	5	9
	The library staff was not cooperative or helpful in getting me the report	1	2	3	4	5	9
	The report was classified or restricted	1	2	3	4	5	9
	The report was available only to U.S. citizens	1	2	3	4	5	9
	The report had to be obtained from either NTIS or NASA	1	2	3	4	5	9

Other (specify)\_\_\_\_\_

	USING NASA TECHNICAL REPORTS	Frequently				Never	Not Applicable
	Illegible microfiche	1	2	3	4	5	9
	Illegible text		2	3	4	5	9
	Illegible graphics (e.g., charts, photos, figures)		2	3	4	5	9
	Poor report organization/ format/presentation	1	2	3	4	5	9
	Intellectual quality of the research	1	2	3	4	5	9
	Other (specify)						
14.	How would you rate NASA technical re	ports on each o	f the foll	owing fac	tors? (C	ircle numbers	)
		Very				Not At all	Don't Know
	ACCESSIBILITY: the ease of getting to the information source	1	2	3	4	5	9
	EASE OF USE: the ease of	Easy				Difficult	Don't Know
	comprehending or utilizing the information	1	2	3	4	5	9
	·	Not Expensive				Very Expensive	Don't Know
	EXPENSE: low cost in comparison to other information sources	1	2	3	4	5	9
	FAMILIARITY OR EXPERIENCE:	Very Familiar				Not at all Familiar	Don't Know
	prior knowledge or previous use of the information source	1	2	3	4	5	9
	TECHNICAL QUALITY OR RELIABILITY: the information	Excellent				Poor	Don't Know
	was expected to be the best in terms of quality, accuracy and reliability	1	2	3	4	5	9
	COMPREHENSIVENESS: the	Excellent				Poor	Don't Know
	expectation the information source would provide broad coverage of the available knowledge	1	2	3	4	5	9

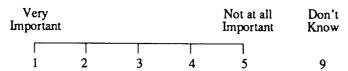


17. Have you received instruction in how to use the engineering or departmental library? (Circle answer					
	YES —	NO			
	Was the instruction? (Circle all that apply)	Was instruction in how to use the library available to you? (Circle number)			
	<ul><li>a. A credit course</li><li>b. A non-credit course</li><li>c. A required course</li></ul>	1 Yes — What was your primary reason for not taking it?			
	d. An elective course e. As part of an engineering course f. As part of another course g. As a separate course h. Other (specify)	3 Don't know			
18.	•	information resources and materials? (Circle answer)			
	YES —	NO —			
	Was the instruction? (Circle all that apply)	Was instruction in engineering information resources and materials available to you? (Circle number)			
	<ul> <li>a. A credit course</li> <li>b. A non-credit course</li> <li>c. A required course</li> <li>d. An elective course</li> <li>e. As part of an engineering course</li> <li>f. As part of another course</li> <li>g. As a separate course</li> <li>h. Other (specify)</li> </ul>	1 Yes What was your primary reason for not taking it? 2 No 3 Don't know			
19.	Have you received instruction in searching or	nline (electronic) databases? (Circle answer)			
	Was the instruction? (Circle all that apply)	Was instuction in searching online (electronic) databases available to you? (Circle number)			
	<ul> <li>a. A credit course</li> <li>b. A non-credit course</li> <li>c. A required course</li> <li>d. An elective course</li> <li>e. As part of an engineering course</li> <li>f. As part of another course</li> <li>g. As a separate course</li> </ul>	1 Yes What was your primary reason for not taking it?  2 No  3 Don't know			
	h. Other (specify)	L			

20. How important do you think an understanding and knowledge of engineering information resources and materials will be to your success as an engineer? (Circle number)

Very Important				Not at all Important	Don't Know
1	2	3	4	5	9

21. How important do you think the ability to communicate technical information effectively will be to your success as an engineer? (Circle number)



Finally, we would like to collect some background information that will help to analyze the data.

- 22. Gender:
  - 1 Female
  - 2 Male
- 23. U.S. Citizen:
  - 1 Yes
  - 2 No
- 24.. Year:
  - 1 Junior
  - 2 Senior
  - 3 Graduate Student
  - 4 Other (specify)
- 25. COOP student: (Past or current)
  - 1 Yes
  - 2 No

OVER ----

26.	Major:	
	<ol> <li>Aero/Astro Engineering</li> <li>Architecture</li> <li>Civil Engineering</li> <li>Electrical Engineering</li> <li>Mechanical Engineering</li> </ol>	6 Ocean Engineering 7 Physics 8 Textile Engineering 9 Other Engineering (specify) 10 Other (specify)
27.	In the past school year have you worked on "Advanced Engineering Design Program"	on a NASA or DOD grant or contract, other than the USRA
	1 Yes	
	2 No	
28.	Professional (national) student membersh	ip:
	1 AIAA	5 Other scientific, engineering or technical society
	2 ASME	or technical society
	3 IEEE	6 Not a student member of any scientific, engineering, or technical society.
	4 SAE	engineering, of technical society.
1.		OPTIONAL QUESTIONS  n(s) students face in finding out and obtaining the results of
2.	What suggestions can you offer for improvir	ng students' access to the results of NASA research?
3.	Is there anything else you would care to say	regarding this research?

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